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Remote patient monitoring system for older rural population – pilot project in Sisak Moslavina County

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Abstract

Background and Purpose: *The aim of this study is to evaluate the use of Eriscsson Mobile Health (EMH) system for rural, distant, older, chronically ill patient monitoring in Sisak Moslavina County in the region of ASSC. The aim is to evaluate quality, patient satisfaction, health care provider satisfaction with EMH system as well as possible obstacles and points for possible cost savings.*

Materials and Methods: *The solution we tested is Ericsson Mobile Health (EMH), a mobile medical device of class IIa, composed of several components that include package for patient, server and applications. Package for patient includes several sensors depending on type of monitoring, communication device and expendable material. Package for patient consists of sensors for Pulse Oximetry (SaO_2), Electro Cardio Graph (ECG), Peak Expiratory Flow (PEF) and Forced Expiratory Volume in 1 Second (FEV1), Blood Pressure (BP) and Blood Glucose Level. Communication device is central part of patient package. It collects sensor measurements available via Bluetooth interface and it sends them towards server available via mobile network. Doctor access to server and browse through patient data using application for doctors. As a method for evaluation we used interviews with open-ended questions for both patients and medical personnel. Data were analyzed using qualitative conventional content analysis.*

Results: *Common denominator in all interviews with patients was feeling of security and possibility of quick intervention if needed. Also, they felt they can substantially save on transportation. Medical personnel observed mainly technical objections regarding devices. As for benefits they recognized continuity of care, easy access to primary care, responsiveness to specific patients needs, in one visit field nurse can cover group of patients, and accurate data for decision making.*

Conclusion*: EMH is adaptable and secure system that can reduce costs of health care in distant rural areas both for population and health care system. Direct link with primary health care provider contributes to the patient's feeling of security.*

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INTRODUCTION

Health care in Croatia is organized on principles of inclusion, continuity and availability and it is guaranteed by both the Constitution *(1)* and the Law on health care *(2)*. Croatia is also accepted principles of "equal opportunities" that are valued in European society, believing that health inequalities affect human productive and creative

potential. However, economic and political changes, cultural heritage appear as barriers in health care use and availability crating inequalities within the population. Croatia is predominantly rural country with around 90% of territory classifies as rural with 48% of total population living in those areas. Geographically Croatia is extremely diversified from high mountain ranges to 1200 islands out of which 50 are inhabited all year around and about 10 seasonally *(3)*. This situation influence economic orientation and organization of public services such as: education, health care, water supply or transportation. Demographic situation is another factor that influences state organization. Croatian society is aging rapidly with increasing number of single person households in both rural and urban areas. In Croatia every fifth citizen is older than 65 years. With age we can observe the increase in chronic diseases, increase in demand for health care services while at the same time healthcare system due to general crisis is constrained to provide all those services with fewer resources *(4)*. This is challenging for rural areas, particularly in the Areas of special state concern (ASSC), which at the moment inhabit around 15% of the total Croatian population. ASSC are defined as underdeveloped below average by reference to economic, demographic and certain other additional criteria *(5)*. Regarding health care services population in those regions have difficulties reaching primary health care facilities due to the poverty, older age and lack of public transportation *(6, 7, 8)*. Along with that insufficient health care budget create problems with staff recruitment, while health care reforms promote shorter hospital stay shift to home and community care with enhancement of rehabilitation creating difficult situation and lower access to health care in already underprivileged population. As one of the possible means of response to these challenges is use of information and communication technology (ICT) for distant home care and home monitoring. So far those solutions were used mostly for cardiovascular patients for direct connection with coronary units, who were in financially well of situations *(9, 10),* but today paradigm has shift because prices of those solutions and their use has decreased and they are widely used as a health care tool in distant rural areas such as native Alaskan, Inuit or Hawaiian populations *(11, 12)*. In such a way the cost of providing health care service in rural difficult to reach geographic areas is decreased and ambulatory patients are able to continue living at home rather than nursing facilities. As a curiosity telemedicine was practiced even on the Mt. Everest demonstrating utilization of ICT as healthcare tool in even most extreme of settings *(9)*.

The aim of this study is to evaluate the use of Eriscsson Mobile Health (EMH) system for, rural, distant, older, chronically ill patient, monitoring in Sisak Moslavina County in the region of ASSC. The aim is to evaluate quality, patient satisfaction, health care provider satisfaction with EMH system as well as possible obstacles and points for possible cost savings.

METHODS

Piloting of the method was conducted in the ASSC in the Sisak Moslavina County. Area fulfilled the requirements by several factors: older population; 70% of inhabitants are 65 or older, small number of approximately 150 inhabitants in three scattered villages (Sjeverovac, Staro selo, Velika Gradusa). Distance from primary health care center is 13 km for two villages and 28 km third. School bus is operating once a day in each direction, but regular transportation is not available. Villages Velika Gradusa and Sjeverovac are classified as first category, and village Staro Selo as second category of ASSC *(5)*. We approached chronically ill patients who participated in previous studies *(6, 7, 8)* and measured all available parameters.

The solution we tested is EMH, a mobile medical device of class IIa, certificated by DNV in accordance the conformity assessment procedure described in Article 11.3.a and Annex II excluding section 4 of Council Directive 93/42/EEC on Medical Devices. EMH has EC declaration of conformity and CE 0434 mark given by DNV *(13)*. Primarily is used for remote monitoring of chronically ill patients in area of cardiology and pulmology. EMH can also be used in homecare or after medical intervention, for preventive checkups, rural healthcare, medical triage or wellbeing programs.

EMH is integrated with patient electronic health records in primary health care office, and system is composed of several components that include package for patient, server and applications. Package for patient includes several sensors depending on type of monitoring, communication device (smart phone) and material like batteries, chargers, reagents, papers, strips etc. Communication device is central part of patient package. It collects sensor measurements available via Bluetooth interface and it sends them towards server available via mobile network. Doctor access to server and browse through patient data using application for doctors. Package for patient consists of sensors for following parameters: Pulse Oximetry (SaO_2) non-invasive measure expressed as percentage of oxygen in one's hemoglobin, Electro Cardio Graph (ECG), a one lead-system only measures the ECG at one point, by using 3, 5 or 12 leads the ECG resolution is improved enabling better interpretation, Peak Expiratory Flow (PEF) and Forced Expiratory Volume in 1 Second (FEV1), Blood Pressure (BP) non-invasive measure, Blood Glucose Level testing is based on the measurement of electrical current generated by the reaction of glucose with the reagent of the strip *(13)*.

As a method for evaluation we used interviews with open-ended questions for patients and medical personnel. Data were analyzed using qualitative conventional content analysis *(14)*.

RESULTS

Final sample consisted of 41 participants who had chronic pulmonary, cardiovascular diseases or diabetes. 32 participants were older than 65. Data were collected

by medical doctors with participant's active involvement. Obtained data were sent to server in primary health care office. Around 10% of younger participants could perform measures by themselves.

Interview results revealed population openness towards intervention, all approached inhabitants agreed to participate. Also, it revealed that participants in general feel as if they are forgotten and abandoned from social and health institutions. Direct care and possibility of being in connection with health care provider brings feeling of better quality of life and better cost control. Common denominator in all interviews was feeling of security and possibility of quick intervention if needed.

Doctors who performed measurements in the field felt that operating devices was not difficult. However they observed two groups of objections that we can classify as technological and financial. Technological objections regarding device included poor quality of ECG readings both on communication device and computer or printout at doctor's office. In the field only basic readings could be done like alterations in heart rhythm, heart beat, hypertrophy or ischemic changes. Nevertheless this was sufficient for of trained medical personnel for medical triage in terms of problem solving in the field in accordance with primary health physician or decision for transportation into medical institution. Following that objections were regarding managing application on the communication device that require some instructions and that application was in English. In addition objection included stability of the network. Such a, poor and isolated, areas have poor mobile internet coverage so we had to look for elevated spots like hills, balconies or top floors in the houses or clear spots in the field in order to connect and send data to the server. Financial objections are regarded high price of the communication devices that are necessary for the data transfer. Possible benefits could be observed from the patient's point of view and from the health care system point of view. Patients were saving on transportation cost which could reach up to 100 Kuna (13,5 Euro) in one direction with local taxi. Given the fact that most of them live on minimal agricultural retirement which is around 200 Euro or social welfare which is around 100 Euro, this is considerable sum. They cannot reimburse expenses from health insurance company because health care center is less than 50 km away. Also patients get diagnostic or follow up measurements in real time and in the environment they live. Medical personnel observed as benefits continuity of care, easy access to primary care and eventually in future development with specialists, responsiveness to specific patients needs, in one visit field nurse can cover group of patients and accurate data for decision-making.

DISCUSSION

Since mid eighties when introduction of ICT in health care business started tremendous progress has been made. As systematized by Haux *(15)* shift from paper based to computer based processing and storage, increase of health care data and expansion of data users from administration and medical personnel to patient and health care planners and clinical and epidemiological researchers is observed. Further we can see the shift from focusing mainly on technical problems to those of management and strategic information management, along with shift from mainly alpha-numeric data, to images and now sensor based technologies. In terms of patient monitoring we can follow development from telephone and video communication to smart homes for elderly equipped with virtual eyes *(16)*, wireless body sensor networks *(17, 18)* even robots as intermediates between patients in distant rural areas and medical doctors *(11, 12)*. All studies emphasize both the patient and health care benefit in sense of cost savings through reduced visits to the doctor's offices, reduced cost of transportation or emergency interventions or possibility to have home care instead of moving into elderly nursing facilities. However, technological approach may lead to possible reduced doctor patient live contact. It is clear that technology cannot substitute for face to face contact and examination, so initial patient doctor interaction should be in person to build relationship, as well as follow up via ICT solutions should be always with same provider.

Our results add another dimension in the form of a model of collaboration established on results collected during four year research where actual project is innovative multidimensional answer to population needs, recognized during mentioned research *(6, 7, 8)*. Creation of model of synergy between local community, health care system and ICT Company in fact empowers rural communities especially older inhabitants in distant and isolated villages. Such an association lowers the cost of the service because field nurses could measure needed parameters to all inhabitants in one village at single visit and send them to the doctor's office without unwanted errors in the communication. ECG or spirometry could have been done, so far, only in specialized institutions or emergency vehicles. Inhabitants from isolated villages would have to travel for hours to such institutions and often due to lack of resources, older age and geographical distance they give up diagnostics, check up or medication purchase. Sisak Moslavina County has one general hospital, it covers around 8% of area of Republic Croatia, with around 4% of total population. Those parameters make it relevant example of environment with need for distant medical care. However development of such a model that could be adapted based on specific population needs have a great potential particularly in the country with around 60 inhabited islands where ensuring transportation is not always easy. On the other hand it is easy to provide EMH set which can connect inhabitants with medical service in real time. Problem with Croatian island is present for years; population is old with multiple chronic disease diagnosis, while primary care is not continuously available. There have been some ideas about polyclinic on the boat that would serve

more than 125.000 inhabitants on the Croatian islands but price of such a boat is far too big for Croatian health care budget *(19)*.

What remains are adaptable ICT models tailored for the local population needs. Benefits for population are not expressed only in health and economic sense, but in the value of personal contact and home visits, value of health education and measures for health improvement. Older population in isolated rural areas sometimes is perceived only as a burden to society. As being less productive they are tacitly perceived as "poor investment" for state or health care system. But in the view of demographic changes and the fact that by the 2050 we can expect turning point in human history when there will be more people aged 80 and older than children under 14 years of age *(20),* we cannot allow ourselves marginalization of older population. Croatia struggles with financial crisis that particularly reflects on older people and their health indicators. However, if older person are perceived as a source of cultural heritage and historical witnesses, models of resilience and resourcefulness, or carriers of knowledge and experience for local resources and values, they can become "backbone" of community survival. Such a community survival and revitalization is essential for Croatia with vast empty territories that once were active communities.

Following the World Health Organization (WHO) Active Ageing framework, that integrates several policy domains and all sectors of society, promoting active ageing means creating supportive and enabling environments at all stages of life and for the wide range of functional capacities. WHO is shifting policy action away from a needs-based approach towards right-based approach *(21)*. Active ageing recognizes the rights of people to health, participation and security, and we are sure that proposed model of EMH can contribute to that in Croatian circumstances.

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